DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

AND

FIRE OFFICES' COMMITTEE

JOINT FIRE RESEARCH ORGANIZATION

FIRE RESEARCH NOTE

NO. 508

RADIATION FROM FIRES IN SPIRIT STORAGE BUILDINGS

by

D. J. RASBASH

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November, 1962

Fire Research Station.
Boreham Wood.
Herts.
('phone ELStree 1341)

F.R. Note No. 508

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SUMMARY

An outline is given of a calculation for estimating boundary distances for spirit storage premises, taking into account the large flame that may be present above the roof of such a building during a fire.

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Introduction

If a fire occurs in a building then a neighbouring building might become ignited by radiation if it is less than a certain critical distance away. This concept forms the basis of the draft Scottish Building Regulations for defining the distance between a building and the boundary of the land on which it is built. However, these regulations do not take into account the possibility of radiation obtained from a flame above the roof. In the particular case of buildings used as a spirit store the possibility exists that in the course of a fire, an explosion may take place which would disrupt the roof, thereby producing a large flame above the roof. Even if an explosion does not take place the possibility also exists of a prolonged intense fire in which the roof could collapse. For these reasons it is necessary for this particular risk to take into account radiation that could be obtained from flames above the roof in estimating boundary distances.

Size of flame of open fires

A fire in a building in which a large area of the roof has collapsed or has been blown off would be very similar to an open fire of the same area. Thomas(1) has presented a correlation for the size of flames of open fires. This correlation which is shown in Figure 1 covers a wide range of experiments carried out in different laboratories and certain large fires which have occurred in practice. The height of the flames L is expressed as the ratio of $\frac{L}{D}$ in the ordinate, D being the linear horizontal dimension of the fire. The abscissa is a dimensionless group Z which contains the rate of burning $\dot{m}''$ of the fire and the dimension of the fire (D).

From pictures of the whisky storage fire at Arbuckle Smith Ltd., in March 1960 it is possible to obtain an estimate of the height and the linear dimension of the fire as being about 110 and 220 feet respectively. This gives a value of the ratio of $\frac{L}{D}$ as 0.5. On the basis of available information on burning rates for liquids it may be assumed that the mean burning rate of the alcohol is between 15-25 lb/hr. per sq. ft of surface, it is possible also to estimate a corresponding value for dimensionless group Z. The point for the whisky storage fire, therefore, falls on figure 1 at the place indicated. It is, therefore, in line with the general correlation presented. Points for small scale alcohol fires burning in the laboratory are also indicated and are also consistent with the correlation.

It is possible to use the information in Figure 1 to arrive at an estimate of the size of flame that may occur above the roof of a compartment in which there is a severe spirit fire. For floor areas of the order of 5,000 to 20,000 sq ft the value of Z is between 1×10^{-3} and 1.5×10^{-3} it follows from Figure 6 that the height of the flames above the roof is 0.6 D where D is the linear dimension of the fire. For rectangular premises it is a sufficiently good approximation that D is taken to be the square root of the product of the length and the width of the premises. However, the height of flame arrived at in this way will be an over-estimate of the height which should be used in calculations for radiation exposure for three reasons, firstly because the emissivity of a spirit flame is not as high as the emissivity of solid fire flame, secondly because it is unlikely that the whole roof area would collapse during the course of a fire, thirdly the section of the flame is triangular rather than square. If the assumptions are made that only two thirds of the roof area collapses or is blown off and the top 10 feet of the flame above the roof has a sufficiently low emissivity to allow radiation to be neglected then for purposes of calculating radiation the height of the flame above the roof may be reduced to[1] $L = 0.4 \sqrt{B W}$ where B and W are the dimensions of the compartment.

Calculated separation distances

Table 1 shows boundary distances for compartments of different areas and different length to width ratio. These distances are for flames above the roof only and do not take into account any flames that may be coming from windows below roof level. These distances are based on boundary distances for different exposures given by M. Law[2] the dimensions of the exposed flame being the height as given by equation 1 and the larger linear dimension of the compartment. It will be seen from Table 1 that boundary distances are in some cases quite large; they are considerably larger than distances for single-storey buildings of the same floor area when radiation is from the walls only.

References

1. P. H. THOMAS. F.R. Note No. 497

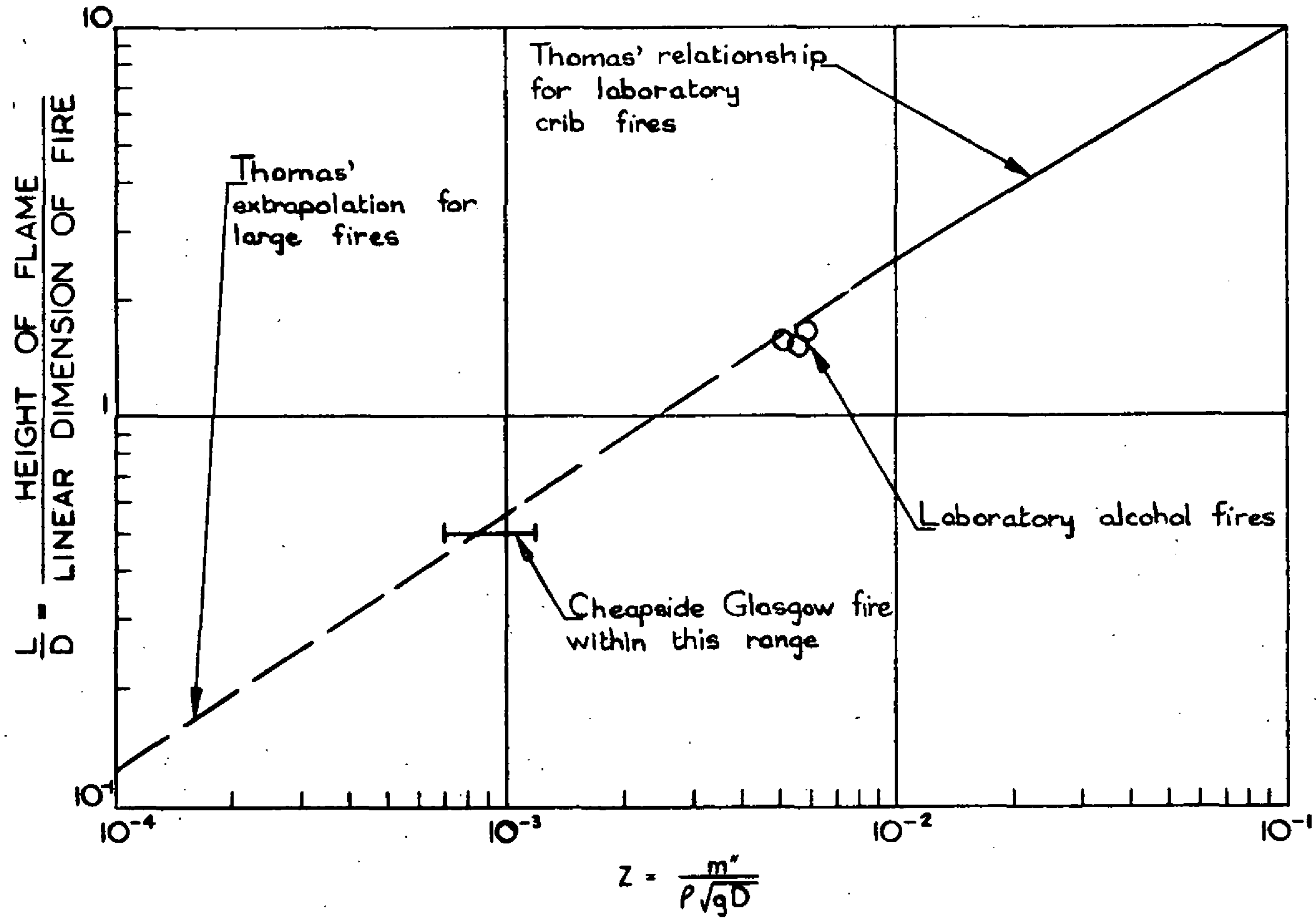
2. M. LAW (Miss) Heat Radiation from Fires and Building Separation F.R. Tech. Paper No. 4.

Table 1

Boundary distance for flames from roofs of spirit warehouses

(based on height of flame seen by receiving surface $L = 0.4 \sqrt{BW}$)

Floor area of division or compartment	Ratio of length B to width W of compartment		
	1:1	2:1	3:1
	Distance in feet from boundary.		
5,000	40	50	60
10,000	60	70	80
20,000	90	100	110



m'' = Rate of burning of fire per unit area

ρ = Gas density

g = Acceleration due to gravity

FIG. 1. HEIGHTS OF FLAMES OF DIFFERENT SIZE FIRES